(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 283 200 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: 10.08.94

(51) Int. Cl.5: B29D 7/00, //B29K105:04

(21) Application number: 88302051.3

(22) Date of filing: 09.03.88

(54) Breathable films prepared from melt embossed polyolefin/filler precursor films.

(30) Priority: 11.03.87 US 24503

(43) Date of publication of application:
21.09.88 Bulletin 88/38

(45) Publication of the grant of the patent:
10.08.94 Bulletin 94/32

(84) Designated Contracting States:
AT BE CH DE FR GB IT LI LU NL SE

(56) References cited:
EP-A- 0 232 060
DE-A- 3 436 065
FR-A- 2 074 338
US-A- 3 407 253
US-A- 4 135 023
US-A- 4 350 655
US-A- 4 472 328

JAPANESE PATENT GAZETTE, section CH, week 7618, Derwent Publications Ltd,London, GB; & JP-A-51 030 856 (SHOWA DENKO K.K.)

(73) Proprietor: EXXON CHEMICAL PATENTS INC.
1900 East Linden Avenue
Linden, New Jersey 07036-0710(US)

(72) Inventor: Sheth, Paresh Jaswantlal
3102 Deer Creek Drive
Sugarland Texas 77478(US)

(74) Representative: Veldhuizen, Albert Dirk Willem et al
Exxon Chemical Limited
Exxon Chemical Technology Centre
PO Box 1
Abingdon Oxfordshire OX13 6BB (GB)

Rank Xerox (UK) Business Services
(3.10/3.09/3.3.3)

Description

Field of the Invention

The invention relates to breathable polymer films --polymer films which are gas/vapor permeable and liquid impermeable -- prepared from highly filled polyolefin film.

Related Art

It is known to prepare porous polyolefin films by stretching a precursor film filled with calcium carbonate. "Breathable" films which are gas/vapor permeable and liquid impermeable have been described in U.S. Patent No. 4,472,328, assigned to Mitsubishi Chemical Industries, Ltd. The Mitsubishi patent describes a breathable polyolefin film prepared from a polyolefin/filler composition having from 20 percent to 80 percent by weight of a filler such as a surface treated calcium carbonate. A liquid or waxy hydrocarbon polymer elastomer such as a hydroxy-terminated liquid polybutadiene was found to produce a precursor film that could be monoaxially or biaxially stretched to make a film breathable. The breathable film described by Mitsubishi is also described in Great Britain Patent No. 2,115,702, assigned to Kao Corporation. The Kao patent further describes a disposable diaper prepared with a breathable film as disclosed by the Mitsubishi patent. The breathable film is used as a backing for the diaper to contain liquid.

U.S. Patent No. 4,350,655, assigned to Biax Fiber Film, describes a porous polyolefin film containing at least 50 percent by weight of a coated inorganic filler. The precursor film is formed without the addition of an elastomer by employing an inorganic filler surface coated with a fatty acid ester of only silicon or titanium. The precursor film is then rolled between horizontally grooved rollers. Cold stretching of the precursor film at a temperature below 70 °C produces a porous film. Some of the resulting films were stated to be both vapor and liquid permeable, however, at least one film (Example3) was stated to be permeable to air.

EP-A-232 060 of earlier priority date and to be considered under Article 54(3)EPC describes the production of a gas-permeable porous film of LLDPE produced by mixing the LLDPE and a filler, extruding a film, embossing and stretching the film. The film so posseses a rugged pattern on the surface. The pattern is produced by an embossing roller and may be applied before and/or after stretching of the film. The pattern may be e.g. a satin finish or in the form of lines. US-A-4,921,653 equivalent to the above defines the rugged pattern as having peaks and valleys with a depth therebetween of from 2 um to 3 mm. EP-A-232 060 does not disclose the specific nature of the LLDPE other than the melt index.

The present invention provides a method of making a breathable film comprising the steps of :

- mixing a linear low density polyethylene copolymer produced by polymerising ethylene with a C_{4-10} alpha olefin with a filler,
- extruding a precursor film from the copolymer /filler mixture,
- melt imbossing the film to impose therein a pattern of areas of different film thicknesses, and
- stretching the film to impart greater vapor permeability in areas of reduced thickness in comparison to areas of greater thickness.

The film may be produced by tubular extrusion and embossed thereafter. Preferably a precursor film is cast extruded and embossed prior to stretching.

The invention is inclusive of breathable film obtainable by the method described above characterised by a pattern of areas of different film thicknesses with greater vapor permeability in areas of reduced thicknesses in comparison to areas of greater thickness and an overall water vapor transmission rate in excess of 5,800 g/m^2/day.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

Film Forming Compositions

Linear low density polyethylene (LLDPE) as used in the present invention is produced by copolymerizing ethylene with a C_4 to C_{10} alpha-olefin. Generally the preferred alpha-olefins include those selected from the group comprising butene-1, pentene-1, hexene-1, 4 methylpentene-1, heptene-1, and octene. The comonomers are present in amounts up to 20 wt. %, normally between 3 and 14 wt. %. The polymerization is conducted at low pressure using a chromium catalyst or Ziegler catalyst and may be carried out in the gas phase. The LLDPE produced by such methods have a density between 0.900 and 0.935 g/cm^3 and a melt index (MI) between 0.1 and 5.0 grams per 10 minutes. Manufacturing processes for production of

LLDPE are known, such as disclosed in U.S. Patent Nos. 4,076,698 and 4,205,021. LLDPE is preferred as the polyolefin component for use in this invention because of its high tear strength, ease of compounding, and low cost.

Fillers useful in this invention may be any inorganic or organic material having a low affinity for and a significantly lower elasticity than the polyolefin component. Preferably the filler should be a rigid material having a non-smooth hydrophobic surface, or a material which is treated to render its surface hydrophobic. The preferred mean average particle size of the filler is between about 3 to 5 µm for films having a thickness of between 102-152 µm (4-6 mil) prior to stretching. Examples of the inorganic fillers include calcium carbonate, talc, clay, kaolin, silica, diatomaceous earth, magnesium carbonate, barium carbonate, magnesium sulfate, barium sulfate, calcium sulfate, aluminum hydroxide, zinc oxide, magnesium hydroxide, calcium oxide, magnesium oxide, titanium oxide, alumina, mica, glass powder, zeolite, silica clay, etc. Calcium carbonate is particularly preferred for low cost, whiteness, inertness, and availability. The inorganic fillers such as calcium carbonate are preferably surface treated to be hydrophobic so that the filler can repel water to reduce agglomeration of the filler. Also, the surface coating should improve binding of the filler to the polymer while allowing the filler to be pulled away from the polyolefin under stress. A preferred coating is calcium stearate which is FDA approved and readily available. Organic fillers such as wood powder, pulp powder, and other cellulose type powders may be used. Polymer powders such as Teflon® powder and Kevlar® powder can also be used.

The amount of filler added to the polyolefin depends on the desired properties of the breathable film including tear strength, water vapor transmission rate, and stretchability. However, it is believed that a breathable film cannot be produced as is taught herein with an amount of filler less than about 15 percent by volume of the polyolefin/filler composition (e.g. LLDPE/$CaCO_3$ having less than about 38 percent by weight $CaCO_3$). The minimum amount of filler is needed to insure the interconnection within the film of voids created at the situs of the filler particularly by the stretching operation to be subsequently performed on the precursor film. Further, it is believed that useful films could not be made with an amount of the filler in excess of about 35 percent by volume of the polyolefin/filler composition (e.g. LLDPE/$CaCO_3$ having greater than about 65 percent by weight $CaCO_3$). Higher amounts of filler may cause difficulty in compounding and significant losses in strength of the final breathable film.

Polyolefin/filler compositions usable in this invention may be compounded in several different ways. The components may be brought into intimate contact by, for example, dry blending these materials and then passing the overall composition through a compounding extruder. Alternatively, the polyolefin and filler components may be fed directly to a mixing device such as a compounding extruder, high shear continuous mixer, two roll mill or an internal mixer such as a Banbury mixer. Overall, the objective is to obtain a uniform dispersion of the filler in the polymer without agglomeration, and this is readily achieved by inducing sufficient shear and heat to cause the polyolefin component to melt. However, time and temperature of mixing should be controlled as is normally done to avoid molecular weight degradation. Compounding of LLDPE and calcium carbonate that is surface treated with calcium stearate has been improved by vacuum drying the mixture within the extruder.

The tear strength and softness of a film prepared from the polyolefin/filler composition may be improved by addition of small amounts of an olefinic elastomer.

Film Extrusion and Melt Embossing

The film forming composition may be manufactured into a precursor film by conventional tubular extrusion (blown bubble process) or by cast extrusion. Film formation by cast extrusion is preferred because the cast film can be immediately melt embossed as described below.

In the cast extrusion process, the molten resin is extruded from an elongate die in the form of a web. The web is pulled over at least one patterned embossing roller to chill and solidify the film with an embossed pattern for reasons discussed further below. The precursor film is preferrably produced to a guage of 102 to 152 µm (4 to 6 mils), which allows for further stretching as described below. The extrusion temperatures, die temperatures, and embossing roll temperatures will depend on the composition employed, but generally will be in the following ranges for compositions of the present invention prepared by cast extrusion:

- Melt Temperature	177-232 °C (350-450 °F)
Die Temperature	177-232 °C (350-450 °F)
Embossing Roll Temperature	21-54 °C (70-130 °F)

Film formation by tubular extrusion produces balanced films having increased film strength in both the machine and cross-machine direction. In the tubular blown film process, the film forming composition is first melted and then extruded through an annular die. The die should preferably have a die gap suitable for extruding LLDPE resin which normally is greater than about 0.5 mm and preferably greater than 0.75 mm. The film forming composition is extruded at a melt temperature between about 150 °C to 300 °C, preferably between 190 °C and 240 °C. The molten composition is preferably extruded in an upward vertical direction in the form of either a bubble or a tube, although it also can be extruded either downwardly or horizontally. The tubular extrudate is expanded to the desired dimensions and then cooled by one of several conventional techniques which are well known in the art, e.g., forced air, mandrel, and water quench. The tubular film, or bubble, is then flattened by passing the film through a collapsing frame and a set of nip rolls. The nip rolls are driven, thereby proving a means of drawing the tubular film or bubble away from the annular die.

A positive pressure of a gas, such as air or nitrogen, is maintained inside the tubular bubble. As is known in the operation of conventional blown film processes, the presence of the gas is controlled to impart a desired dimensional orientation to the film tube or bubble. The degree of tubular bubble expansion may be measured as the ratio of the expanded bubble circumference to the circumference of the die annulus. This ratio is generally in the range of 1 : 1 to 6 : 1 and for a precursor breathable film is preferably from 2 : 1 to 4 : 1.

Embossing is typically used on the surface of polyolefin films to reduce gloss. Embossing can be imposed on the precursor film surface at the time of the film fabrication for cast extrusion, or at a subsequent time for cast or tubular extrusion by procedures well known in the art. For the present invention, embossing imposes a pattern of different film thicknesses within the precursor film, and can be conducted with any micro/macro pattern, e.g. cross-hatching, dots, lines, circles, diamonds, hexegons etc. The pattern can be either in line and/or off line and the rolls can be engraved with either pin up and/or pin down type configurations.

Stretching and Heat Setting

Final preparation of a breathable film is achieved by stretching the precursor film to form interconnected voids. Stretching or "Orientation" of the film may be carried out monoaxially in the machine direction (MD) or the transverse direction (TD) or in both directions (biaxially) either simultaneously or sequentially using conventional equipment and processes following cooling of the precursor film.

Blown films are preferably stretched in the machine direction or in both directions whereas cast films are preferably stretched in the transverse direction. For orientation in the MD, the precursor film is passed around two rollers driven at different surface speeds and finally to a take up roller. The second driven roller which is closest to the take up roll is driven faster than the first driven roller. As a consequence the film is stretched between the driven rollers.

Film orientation may also be carried out in a tentering device with or without MD orientation to impart TD orientation to the film. The film is gripped by the edges for processing through the tentering device.

Stretching of melt embossed precursor films with a tentering device at a film speed of about 60 meters per minute produced breathable films having the desired water vapor permeability. The resulting films had greater permeability in the areas of reduced thickness in comparison to the areas of greater thickness.

Although not thoroughly investigated, controlling of the strain on the film during stretching is believed to be important to controlling the permeability. For stretching in the transverse direction, strain is controlled for a given stretch ratio by adjusting the film speed and the stretching distance. The stretching distance is measured, between the point where the film starts to increase in width to the closest point where the film is fully stretched. For stretching in the machine direction, strain is controlled for a given stretch ratio by controlling film speed and the gap between the first and second driven rollers.

A range of stretching ratios from 1:2 to 1:5 prove satisfactory for MD stretching with a ratio of 1:4 being preferred. A range of stretching ratios of 1:2 to 1:5 prove satisfactory for TD stretching with a ratio of 1:4 being preferred.

The water vapor permeability of the embossed film following stretching, as measured by the final WVTR of the film, was found to be inversely related to the stretching temperature. Stretching at a

temperature of about 45 • C produced a film having a slightly higher WVTR than stretching at temperatures of about 60 • C.

The stretched film can be heat set to stabilize the film for any subsequent processing at temperatures above the stretching temperature. The film can be heat set at any temperature above the stretching temperature and below the softening temperature to add stability. However, higher temperatures cause stiffness and some reduction in WVTR. Heat setting at about 80 • C produced a softer film with substantially higher WVTR in comparison to heat setting at about 95 • C.

It is preferred that tension be maintained on the film during the heat setting and cooling to minimize shrinkback. Upon cooling to ambient temperature (i.e., room temperature) or near ambient, the holding force may be released. The film may contract somewhat (snapback) in the TD but will retain a substantial portion of its stretched dimension.

Heat setting can be accomplished by maintaining the film under tension in the stretched condition at the heat setting temperature for about 1 - 2 minutes. Preferably, however the heat setting and cooling is carried out while permitting the film to contract slightly, but still under stress. The controlled shrinkback of from 5 to 30%, preferably between 15 and 25%, of the maximum stretched width has given particularly good results in eliminating storage shrinkage.

EXAMPLES

The following examples, which illustrate melt embossed breathable films prepared in accordance with the present invention, are not intended to limit the invention to the specific compositions. Other compounds such as elastomers, stabilizers against heat or ultraviolet rays, pigments, antistatic agents, etc. may be added to the compositions in the conventional manner. Variations in composition and manufacturing techniques will be readily apparent to persons skilled in the art of manufacturing polyolefin films and are within the scope of this invention. In the examples which follow water vapor transmission rates (WVTR) were measured in accordance with ASTM F372-73 using a Permatran® WI analyzer manufactured by Modern Controls International Inc.

Example 1 (COMPARISON)

A linear low density polyethylene which consisted of a copolymer of ethylene and hexene-1 was compounded with an equal weight of a surface treated calcium carbonate. The calcium carbonate was surface treated with calcium stearate to render the surface of the particles hydrophobic. The resulting formulation was cast extruded into a precursor film having a thickness of approximately 102 to 152 µm (4 to 6 mil).

The resulting precursor film was cooled and then subjected to tentering stress in the transverse direction with a stretch ratio of 4 to 1 and a film speed of about 60 meters per minute. Stretching was performed in a tentering frame with heat applied only to the final zone of the tentering frame. The temperature of the film in the final zone was maintained at about 93 • C. As a result of convection within the tentering frame, stretching of the film occurred at approximately 60 • C. The film became white and breathable when stretched and retained those properties following the heat setting treatment. The final breathable film had a water vapor transmission rate of up to 5800 grams per square meter per day at 38 • C.

Example 2

The LLDPE/calcium carbonate composition of Example 1 was cast extruded under the same conditions as Example 1. The precursor film was passed between a smooth roller and a diamond patterned embossing roller. The resulting film had a thickness of approximately (102 to 152 µm) (4 to 6 mil) and a diamond pattern on one side. The film became whiter when stretched at the temperature and conditions stated for Example 1. Heat setting was also conducted as described for Example 1. This film had a WTVR value of 8,100 grams per square meter per day. Stretching caused greater permeability in the thin portions of the film created by the embossing roll in comparison to the thick area which retained greater strength. The final film had a drapy and softer film structure and a higher tear strength than the film of Example 1.

Example 3

The LLDPE/filler composition of Example 1 was extruded and melt embossed under the same conditions of Example 2. The precursor film was then stretched with the tentering device of Example 2. The

temperature of the film in the heat setting zone was maintained at about 78°C and stretching occurred at about 35°C. The final film had a WTVR value of 10,300 grams per square meter per day.

Example 4

A breathable film was prepared under the same conditions of Example 3 except that the stretching temperature was adjusted to 70°C. The final film had a WVTR value of 10,000 grams per square meter per day.

Example 5

A breathable film was prepared under the same conditions of Example 3 except that the stretching temperature was adjusted to 93°C. The final film had a WVTR value of 9,900 grams per square meter per day.

The following table presents a comparison of the variables in Examples 1-5.

	Stretch Temp., °C	Heat Set Temp., °C	WVTR $g/m^2/day$
Example 1 (Comparison)	60	93	5,800
Example 2	60	93	8,100
Example 3	35	78	10,300
Example 4	70	78	10,000
Example 5	93	78	9,900

USES

The breathable films of the present invention can replace currently available breathable films in such applications as diaper back sheets and light weight camping and backpacking equipment. Breathable films are expected to have a wide variety of applications in the fields of medical and surgical supplies, apparel and household furnishings, tape and packaging, and filtration membranes. For example, breathable films can be used to replace porous films in applications such as burn dressings, sterile packaging, rain coats, shoe linings, nonfogging packaging film, bacteria filters, water purification filters, and wind insulation of houses and buildings.

Claims

1. Method of making a breathable film comprising the steps of :
   mixing a linear low density polyethylene copolymer produced by polymerising ethylene with a C_{4-10} alpha olefin with a filler,
   extruding a precursor film from the copolymer/filler mixture,
   melt embossing the film to impose therein a pattern of areas of different film thicknesses, and
   stretching the film to impart greater vapor permeability in areas of reduced thickness in comparison to areas of greater thickness.

2. Method according to claim 1 wherein the filler is calcium carbonate treated with calcium stearate.

3. Method according to claim 1 or claim 2 wherein the copolymer/filler mixture contains from 15 to 35 vol % filler.

4. Method according to any preceding claim wherein said alpha-olefin is selected from butene-1, pentene-1, 4-methylpentene-1, heptene-1 and octene.

5. Method according to any of claims 1 to 3 wherein said alpha-olefin is hexene-1.

6. Method according to any preceding claim wherein said alpha-olefin is present in amount from 3 to 14 wt %.

7. Method according to any preceding claim wherein said LLDPE copolymer has a density from 0.900 to 0.935 g/cm³.

8. Method according to any preceding claim wherein the unstretched film has a thickness from 102 to 152 µm (4 to 6 mil).

9. Method according to any preceding claim wherein the film is produced by tubular extrusion and embossed thereafter.

10. Method according to any of claims 1 to 8 wherein a precursor film is cast extruded and embossed prior to stretching.

11. Method according to claim 10 wherein the precursor film is extruded at a melt and/or die temperature from 177 to 232 °C (350 to 450 °F.)

12. Method according to claim 10 or claim 11 comprising the step of heat setting the stretched film at a temperature above the stretching temperature and below the softening temperature of the stretched film.

13. Method according to claim 12 wherein the stretched film is heat set at a temperature from 60 to 95 °C.

14. Breathable film obtainable by the method of claim 1 characterised by a pattern of areas of different film thicknesses with greater vapor permeability in areas of reduced thickness in comparison to areas of greater thickness and an overall water vapor transmission rate in excess of 5,800 g/m²/day.

15. Breathable film according to claim 14 having a said pattern of areas in the form of circles or hexagons.

16. Breathable film according to claim 14 having a said pattern of areas in the form of diamonds.

Patentansprüche

1. Verfahren zur Herstellung einer atmungsaktiven Folie, bei dem
   ein lineares Polyethylencopolymer mit niedriger Dichte (LLDPE-Copolymer), das durch Polymerisieren von Ethylen mit C_4- bis C_{10}-α-Olefin hergestellt worden ist, mit einem Füllstoff gemischt wird,
   eine Vorstufenfolie aus der Copolymer/Füllstoff-Mischung extrudiert wird,
   die Folie schmelzgeprägt wird, um sie mit einem Muster aus Flächen mit verschiedenen Foliendicken zu versehen, und
   die Folie gereckt wird, um den Flächen mit verringerter Dicke im Vergleich zu den Flächen mit größerer Dicke eine größere Dampfdurchlässigkeit zu verleihen.

2. Verfahren nach Anspruch 1, bei dem der Füllstoff mit Calciumstearat behandeltes Calciumcarbonat ist.

3. Verfahren nach Anspruch 1 oder Anspruch 2, bei dem die Copolymer/Füllstoff-Mischung 15 bis 35 Vol.% Füllstoff enthält.

4. Verfahren nach einem der vorhergehenden Ansprüche, bei dem das α-Olefin ausgewählt ist aus Buten-1, Penten-1, 4-Methylpenten-1, Hepten-1 und Octen.

5. Verfahren nach einem der Ansprüche 1 bis 3, bei dem das α-Olefin 1-Hexen ist.

6. Verfahren nach einem der vorhergehenden Ansprüche, bei dem das α-Olefin in einer Menge von 3 bis 14 Gew.% vorhanden ist.

7. Verfahren nach einem der vorhergehenden Ansprüche, bei dem das LLDPE-Copolymer eine Dichte von 0,900 bis 0,935 g/cm³ aufweist.

8. Verfahren nach einem der vorhergehenden Ansprüche, bei dem die nicht gereckte Folie eine Dicke von 102 bis 152 µm (4 bis 6 mil) aufweist.

9. Verfahren nach einem der vorhergehenden Ansprüche, bei dem die Folie durch Schlauchextrusion hergestellt und danach geprägt wird.

10. Verfahren nach einem der Ansprüche 1 bis 8, bei dem eine Vorstufenfolie durch Flachfolienextrusion hergestellt und danach geprägt wird, bevor sie gereckt wird.

11. Verfahren nach Anspruch 10, bei dem die Vorstufenfolie mit einer Schmelz- und/oder Düsentemperatur von 177 bis 232 °C (350 bis 450 °F) extrudiert wird.

12. Verfahren nach Anspruch 10 oder Anspruch 11, das die Stufe umfaßt, in der die gereckte Folie bei einer Temperatur über der Recktemperatur und unter der Erweichungstemperatur der gereckten Folie thermofixiert wird.

13. Verfahren nach Anspruch 12, bei dem die gereckte Folie bei einer Temperatur von 60 bis 95 °C thermofixiert wird.

14. Atmungsaktive Folie, die nach dem Verfahren aus Anspruch 1 erhältlich ist, gekennzeichnet durch ein Muster aus Flächen von unterschiedlichen Foliendicken mit größerer Dampfdurchlässigkeit in den Flächen mit verringerter Dicke im Vergleich zu Flächen mit größerer Dicke und einer gesamten Wasserdampfdurchtrittsgeschwindigkeit von mehr als 5 800 g/m²/Tag.

15. Atmungsaktive Folie nach Anspruch 14, bei der das Muster aus Flächen die Form von Kreisen oder Sechsecken hat.

16. Atmungsaktive Folie nach Anspruch 14, bei der das Muster aus Flächen die Form von Rauten hat.

Revendications

1. Procédé de production d'un film apte à la respiration, comprenant les étapes :
   - de mélange d'un copolymère, du type polyéthylène linéaire basse densité, produit par polymérisation d'éthylène avec une alpha-oléfine en C_4 à C_{10}, avec une charge,
   - d'extrusion d'un film servant de précurseur à partir du mélange copolymère/charge,
   - de gaufrage en masse fondue du film pour soumettre ce film à la formation d'un motif de zones d'épaisseurs de film différentes, et
   - d'étirage du film pour conférer une plus grande perméabilité aux vapeurs dans les zones d'épaisseur réduite, comparativement aux zones de plus forte épaisseur.

2. Procédé suivant la revendication 1, dans lequel la charge consiste en carbonate de calcium traité avec du stéarate de calcium.

3. Procédé suivant la revendication 1 ou la revendication 2, dans lequel le mélange copolymère/charge contient 15 à 35 % en volume de charge.

4. Procédé suivant l'une quelconque des revendications précédentes, dans lequel l'alpha-oléfine est choisie entre le butène-1, le pentène-1, le 4-méthylpentène-1, l'heptène-1 et l'octène.

5. Procédé suivant l'une quelconque des revendications 1 à 3, dans lequel l'alpha-oléfine est l'hexène-1.

6. Procédé suivant l'une quelconque des revendications précédentes, dans lequel l'alpha-oléfine est présente en une quantité de 3 à 14 % en poids.

7. Procédé suivant l'une quelconque des revendications précédentes, dans lequel le copolymère du type PELBD possède une masse volumique de 0,900 à 0,935 g/cm^3.

8. Procédé suivant l'une quelconque des revendications précédentes, dans lequel le film non étiré possède une épaisseur de 102 à 152 μm (4 à 6 mil).

9. Procédé suivant l'une quelconque des revendications précédentes, dans lequel le film est produit par extrusion tubulaire et est ensuite gaufré.

10. Procédé suivant l'une quelconque des revendications 1 à 8, dans lequel un film servant de précurseur est extrudé par coulée et gaufré avant étirage.

11. Procédé suivant la revendication 10, dans lequel le film servant de précurseur est extrudé à une température de masse fondue et/ou de filière de 177 à 232 °C (350 à 450 °F).

12. Procédé suivant la revendication 10 ou la revendication 11, comprenant l'étape de thermodurcissage du film étiré à une température supérieure à la température d'étirage et inférieure à la température de ramollissement du film étiré.

13. Procédé suivant la revendication 12, dans lequel le film étiré est soumis à un thermodurcissage à une température de 60 à 95 °C.

14. Film apte à la respiration pouvant être obtenu par le procédé suivant la revendication 1, caractérisé par la présence d'un motif de zones d'épaisseurs de film différentes, avec une plus grande perméabilité aux vapeurs dans les zones d'épaisseur réduite comparativement aux zones de plus grande épaisseur, et une vitesse totale de transmission de vapeur d'eau supérieure à 5800 g/m^2/jour.

15. Film apte à la respiration suivant la revendication 14, possédant un tel motif de zones sous forme de cercles ou d'hexagones.

16. Film apte à la respiration suivant la revendication 14, possédant un tel motif de zones sous forme de losanges.